The adhesive coated lead frame of claim 59, wherein said viscous adhesive material comprises at least one of the group consisting of a polyimide, a phenolic resin, a thermoplastic, and a thermosetting plastic

REMARKS

The Office Action mailed October 3, 2000, has been received and reviewed. Claims 7, 8, and 13 - 16 were rejected. The status of pending claim 21 was not addressed by the Office and Applicants respectfully request the Office to advise the Applicants of the current status of claim 21. Applicants have amended claims 7, 8, 13 - 16, and 21 and have added new claims 22 - 60. Applicants respectfully request reconsideration of the previously rejected claims and consideration of the newly submitted claims in light of the above amendments and the following remarks.

35 U.S.C. § 102(e) Anticipation Rejections

Anticipation Rejection Based on U.S. Patent No. 6,030,889 to Aulicino et al.

Claims 13 and 14 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Aulicino et al., U.S. Patent No. 6,030,889. Applicants respectfully traverse this rejection for the following reasons.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

U.S. Patent No. 6,030,889 to Aulicino et al. ("Aulicino et al.") discusses a method for forming **solder ball** contacts in a ball grid array on a first side of a substrate while simultaneously forming soldered component interconnections on a second side of the substrate. The method discussed by Aulicino et al. generally comprises the steps of: providing a substrate 11 (e.g., a circuit board) having solderable pads 13 on a first surface and solder pads 12 for

electronic component (e.g., semiconductor chip) attachment on a second opposing surface; clamping substrate 11 in a fixture 15 having apertures 19 aligned with solderable pads 13 on the first surface of the substrate; squeegeeing solder paste 21 through apertures 19 in fixture 15 and onto solderable pads 13, **inverting the fixture-substrate subassembly**; placing electronic components 31 on solder pads 12 on the second opposing surface; heating solder paste 21 and solder pads 12 by heating the substrate to form solder balls 41 on solderable pads13 and to join electronic components 31 to solder pads 12 on the second opposing substrate surface; and **removing substrate 11 from the fixture**. (See Aulicino, FIG. 1; and cols. 5-7).

Applicants have amended independent claim 13 to define the invention with more particularity and distinction so as to readily overcome the rejection based on 35 U.S.C. § 102(e). Thus, Applicants submit that Aulicino et al. does not anticipate the invention as presently claimed in claim 13, as amended, because Aulicino et al. does not teach, for example, the following recitations now included in the preamble of claim 13:

A printed circuit board <u>including</u> at least one conductive bump <u>comprised of a viscous conductive material</u>, the at least one conductive bump exhibiting a height-to-width ratio of at least approximately 3 to 1 and including a first surface adjacent said printed circuit board and a second surface opposite said first surface exhibiting a generally planar portion over a substantial portion thereof, said printed circuit board including said at least one conductive bump....

Furthermore, Aulicino et al. does not teach the following recitations that have been added to the body of claim 13:

dispensing a viscous conductive material on said printed circuit board to substantially define at least one conductive bump exhibiting a height-to-width ratio of at least approximately 3 to 1, said at least one conductive bump in electrical communication with said at least at least one bond pad and including a first surface adjacent said at least one bond pad and a second surface opposite said first surface exhibiting a generally planar portion; and

inverting said printed circuit board without effecting substantial lateral confinement of said conductive material and maintaining said printed circuit board in an inverted position at least until said conductive material substantially stabilizes so as to exhibit a desired stable shape and lateral

boundary <u>substantially defining sizes of said first and second surfaces of said at least one conductive bump and wherein a substantial portion of said second surface of said at least one conductive bump exhibits a generally planar configuration.</u>

While Applicants claim a printed circuit board including a conductive bump in which the conductive material thereof obtains a desired stable shape and boundary definition without being substantially laterally confined, the method of Aulicino et al. teaches that the spherically shaped solder balls ultimately obtain their desired stable spherical shape while confined by internal walls 47 in apertures 19 of fixture 15. Importantly, apertures 19 containing solder paste 21 remain in place during the solder reflow formation of solder balls 41, and are not removed until solder balls 41 have been fully formed. Thus, Aulicino et al. teaches that the solder paste 21 and resulting solder balls 41 are laterally confined at all times during final solder ball formation, including when substrate 11 is held in an inverted state.

Furthermore, claim 13, as amended, requires the printed circuit board be inverted without effecting substantial lateral confinement of the viscous conductive material and maintaining the printed circuit board in an inverted position at least until the viscous conductive material stabilizes to define sizes of the first and second surfaces of the conductive bump. Whereas, Aulicino et al. teaches that the solder balls are reflowed while being laterally constrained by the fixture while the fixture and the substrate are inverted.

[&]quot;With substrate 11 held (clamped in fixture 15, the substrate/fixture subassembly is inverted (FIG. 4) and solder 21 is squeegeed into apertures 19 by a squeegee blade 20 or the like. When apertures 19 are filled with solder paste, the subassembly is returned to its upright position . . . The substrate is now ready for heating to simultaneously reflow the solder paste 21 in apertures 19 . . . When heat [] heats the solder paste 21, any flux in the paste is driven off and the remaining solder adheres to the substrate in the form of solder balls 41." (Aulicino, col. 6, lines 50-67 through col. 7, lines 1-2).

[&]quot;Because there is no contact between the fixture's internal walls 47 and solder balls 41, it is thus relatively easy to separate the substrate from the fixture without damaging the extremely small solder ball connections." (Aulicino, col. 6, lines 5-8).

Moreover, claim 13, as amended, now recites that upon the at least one conductive bump substantially stabilizing while held in an inverted position, the at least one conductive bump ultimately exhibits a second surface exhibiting a generally planar portion over a substantial portion thereof. Contrastingly, Aulicino et al. teaches the formation of *ball-shaped* contacts in a ball-grid array arrangement wherein the upper surface of ball contacts 41 after being reflowed by way of being subjected to elevated temperatures, is not planar, but is instead spherical as illustrated in FIG. 7 of Aulicino et al.

Another distinguishing characteristic of Applicants' invention as claimed in claim 13 as compared with the *ball-shaped* contacts of Aulicino et al., is the limitation now included in claim 13 wherein the at least one conductive bump exhibits "a height-to-width ratio of at least approximately 3 to 1. This particular aspect of the at least one conductive bump included in the printed circuit board as claimed is substantially different and readily distinguishable over the *ball-shaped* contacts of Aulicino et al. which are illustrated to exhibit approximately an equal to height-to-width ratio due to the spherical configuration of the ball-shaped contacts taught in Aulicino et al. This particular aspect of Applicants' invention being particularly suitable for providing a conductive bump exhibiting a height that is at least approximately three times greater than its width, and heretofore not obtainable by those practicing in the art, is discussed in the paragraphs beginning in line 14 of page 9 and line 19 of page 17 of Applicants' specification.

Due to the language now included in claim 13 by way of the above amendment to claim 13, the present invention as claimed therein now calls for a semiconductor substrate exhibiting both structural limitations and process limitations not taught or suggested by the Aulicino et al. patent being relied upon by the Office in support of the § 102(e) rejection of claim 13. Such distinguishing elements include the at least one conductive bump being comprised of a viscous conductive material, such as a screen printable or a sprayable viscous conductive material as described for example in the paragraph beginning in line 21 of page 9 of the present specification, and wherein the at least one conductive bump ultimately exhibits a height-to-width ratio of at least approximately 3 to 1. Another exemplarily distinguishing feature of Applicants' invention as claimed in claim 13, as amended above, includes the structural limitation of the at

least one conductive bump including a second surface exhibiting a generally planar portion over a substantial portion of the second surface which faces generally opposite the first surface which is adjacent the printed circuit board, as illustrated in FIG. 5 of Applicants' drawings. Such a generally planar portion as claimed appears not to be present within the generally spherically shaped ball contacts of Aulicino et al.

Because Aulicino et al. does not describe "each and every element" of claim 13 as presently amended, Applicants respectfully request that the anticipation rejection of claim 13 be withdrawn and claim 13 be allowed as it sets forth novel structure and process limitations serving to clearly distinguish Applicants' invention as claimed over the teachings of Aulicino et al.

Applicants' claim 14 directly depends from independent claim 13, and thus inherently incorporates the novel limitations therein. (See 35 U.S.C. § 112, fourth paragraph). Furthermore, claim 14 has been amended to be consistent with claim 13, as amended, as well as to better define the present invention as claimed therein over Aulicino et al. For example, the last line of claim 14 now reads "removing said template prior to substantially inverting said printed circuit board." Contrastingly, Aulicino et al., as pointed out above, discusses how substrate 11 and fixture 15 is held in an inverted state until solder balls 41 form within apertures 19 of fixture 15.

Applicants thus request that the rejection of dependent claim 14 also be withdrawn, and that claim 14 be allowed.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on U.S. Patent No. 6,030,889 to Aulicino et al. and in Combination with U.S. Patent No. 5,586,715 to Schwiebert et al.

Claims 7, 8, 15 and 16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Aulicino et al. (U.S. Patent No. 6,030,889) in view of Schwiebert et al. (U.S. Patent No. 5,586,715). Applicants respectfully traverse this rejection for the following reasons.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

The teachings of Aulicino et al. have been discussed above. U.S. Patent No. 5,586,715 to Schwiebert et al. ("Schwiebert et al.") is directed to a method of flip-chip bump formation. The Office admits that while Aulicino et al. does not explicitly appear to teach a method using a flip-chip substrate, the Office maintains it would have been obvious to use the flip-chip substrate taught by Schwiebert et al. as the substrate of Aulicino et al. (Office Action, at page 3). The Office also maintains that col. 4, lines 49-51, Schwiebert et al. teaches a (flip-chip) product having a bumped adhesive material. In support of the reference combination, the Office cited Aulicino et al., col. 8, lines 17-19 for teaching that "[T]he invention can obviously be applied to any contact arrangement that requires the use of solder balls or the like".

With regard to the first element of a *prima facie* case for obviousness, Applicants submit that there appears to be no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the teachings of Aulicino et al. and Schwiebert et al.

As previously discussed, Aulicino et al. is drawn to a method of forming spherically shaped solder balls on a first side of a substrate, and simultaneously forming soldered component interconnections on a second opposing side of the substrate. To form the solder balls and soldered component interconnections simultaneously, Aulicino et al. teaches generating heat from underneath the fixture 15 and substrate 11. The heat is sufficient to reflow the solder paste 21 in apertures 19, as well as the solder on pads 12 of the opposite side of substrate 11. (Aulicino et al., col. 6, lines 62-65). The heat used for reflow in the Aulicino et al. method is

thus taught to heat each of substrate 11, fixture 15, electronic component 31, and solder on opposing sides of substrate 11.

Applicants further submit that the method of Aulicino et al. is narrowly drawn to joint solder ball formation and solder component interconnection on circuit boards, and that no motivation appears to exist to suggest to one of ordinary skill in the art to combine the Aulicino et al. method with the flip-chip substrate taught by Schwiebert et al. In this regard, Applicants submit that the inversion of substrate 11, as taught by Aulicino et al., is solely for purposes of simultaneous solder reflow and electronic component interconnection. Importantly, Aulicino et al. specifically teaches reflowable solder pads 12 located on the top (second) surface of substrate 11, and an electronic component 31 placed on solder pads 12. When the entire substrate-fixture subassembly is heated sufficiently, the solder on both the bottom and top sides of substrate 11 will reflow, thus forming solder balls 41 and effecting an interconnection between solder pads 12 and electronic component 31 in a simultaneous fashion. Applicants thus submit that the inverted position of substrate 11 serves no other purpose than to allow solder pads 12 and electronic components 31 to be stabilized on substrate 11, such that the reflow of solder paste 21 and solder pads 12 can be simultaneously conducted.

Applicants further submit that one of ordinary skill in the art would not have been motivated to use the flip-chip substrate of Schwiebert et al. in the method of Aulicino et al., since there would not have been any advantage to be gained by using the inversion and heating techniques taught therein. Additionally, Applicants submit that Aulicino et al. teaches heating techniques which would pose a possibility of compromising the operability of a flip-chip, if used as a substrate therein. Specifically, Aulicino et al. teaches reflowing solder paste 21 by heating the entire substrate-fixture subassembly. Thus, Aulicino et al.'s use of intervening fixture 15, apertures 19, and internal walls 47 would require the entire flip-chip of Schwiebert et al. to be heated in order to obtain solder reflow. While in Aulicino et al. substrate 11 is made of circuit board materials which are suitable for withstanding heat sufficient to reflow solder on its opposing sides (see col. 6, lines 22-24), Applicants submit flip-chip materials known at the time of Schwiebert et al., including materials for metallization layers and active circuitry, were not

designed for the heating techniques taught by Aulicino. Applicants thus submit that one of ordinary skill in the art would not be motivated to make the combination of references proposed by the Office.

Applicants further submit, that the Office in citing Aulicino et al., col. 8, lines 17-19 for teaching that "[t]he invention can obviously be applied to any contact arrangement that requires the use of solder balls or the like", may have been taken out of context. The text of the subject paragraph is provided below for ease of reference:

Although the methods of the present invention have been primarily described with respect to forming contacts in a ball grid array, it is not intended that the invention be limited solely to this type of array. The invention can obviously be applied to any contact arrangement that requires the use of solder balls or the like. The invention is intended to include all embodiments amenable to forming contacts in the manner described and as defined by the following claims.

When read in its entirety, Applicants submit the paragraph containing the cited text is intended to state that the method of Aulicino et al. may be used to form <u>varying types of arrays</u> other than ball grid arrays. Furthermore, and as previously discussed, flip-chips are not amenable "to forming contacts in the manner described." Thus, the caveat provided by Aulicino et al. can be construed to teach away from the reference combination, and to limit the use of the methods taught therein to those substrates amenable to the specific heating processes taught by Aulicino et al.

Applicants thus maintain that the first element of a *prima facie* case for obviousness is lacking with respect to claims 7, 8, 15, and 16 because there appears to be no teaching, suggestion, or motivation in the art to combine the cited references. Applicants assert that one might find the present claims obvious by way of impermissible hindsight in light of the teachings of the present application. That is, there must be some teaching, suggestion or motivation in the art, and not in Applicants' disclosure, supporting the Examiner's combination of documents. *See In re Fine*, 5 U.S.P.Q.2d 1596, 1599-1600 (Fed. Cir. 1988) ("One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention"); *Uniroyal v. Rudkin-Wiley*, 5 U.S.P.Q.2d 1434, 1438 (Fed. Cir. 1988) (something in prior art as a whole must suggest desirability of combination). Both the

suggestion to make the claimed combination and a reasonable expectation of success must be founded in the prior art, not in applicant's disclosure. *In re Vaeck*, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). That a prior art device could be modified to produce the claimed device does not justify an obviousness rejection unless the prior art suggested the modifications desirability. *In re Gordon*, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

Notwithstanding the apparent absence of a teaching or suggestion to combine the teachings of Aulicinio et al. with the teachings of Schwiebert et al., the third prong of a *prima facie* case for obviousness clearly has not been met with respect to Applicants' claims 7, 8, 15, and 16, as amended above. That is, even if Aulicinio et al. were to be combined with the teachings of Schwiebert et al., as proposed by the Office, the references do not teach or suggest all the claim limitations set forth in each of Applicants' claims 7, 8, 15, and 16.

Claims 7 and 8 of the present invention are drawn to a semiconductor substrate having at least one adhesive patch having unique structural configurations and are formed in accordance with process steps respectively set forth in each claim. It is noted by Applicants that the Examiner cited Schwiebert et al., col. 4, lines 49-51, as teaching a product having a bumped adhesive material. (*See Office Action*, at page 3). Upon review of this section, however, Applicants were unable to ascertain such a teaching by Schwiebert et al. Furthermore, Applicants were unable to find any teaching in either Schwiebert et al., Aulucino, taken separately or in combination, contemplating the recitation within the preamble of claim 7:

A semiconductor substrate <u>including</u> at least one adhesive patch <u>comprised of a viscous adhesive material</u>, the at least one adhesive patch including a first surface adjacent said semiconductor substrate and a second, smaller surface opposite said first surface exhibiting a generally planar portion over a substantial portion thereof, said semiconductor substrate including said at least one adhesive patch formed by;....

Furthermore, the body of Applicants' claim 7 now reads:

providing a semiconductor substrate;

<u>dispensing a viscous</u> adhesive material on said semiconductor substrate; and inverting said semiconductor substrate <u>without effecting substantial lateral</u>

<u>confinement of said viscous adhesive material and maintaining said</u>

semiconductor substrate in an inverted position at least until said viscous adhesive material sufficiently stabilizes so as to exhibit a desired stable shape and a lateral boundary defining sizes of said first and second surfaces and wherein at least a substantial portion of said second, smaller surface of said adhesive patch exhibits a generally planar configuration and said size of said second, smaller surface is smaller than said size of said first surface.

In contrast to the recitations now included in Applicants' claim 7 regarding the semiconductor substrate including at least one adhesive patch comprised of a "viscous adhesive material, the at least one adhesive patch including a first surface adjacent said semiconductor substrate and a second, smaller surface opposite said first surface exhibiting a generally planar portion over a substantial portion thereof...", Aulicino and Schwiebert et al. both teach the deposition of a solder paste in a stencil to form a spherically shaped solder ball. (See, e.g., Aulicino, col. 6, lines 50-54 [teaching the squeegeeing of a solder paste in aperture 19]; Schwiebert et al., col. 9, lines 30-54 [teaching the metal powder composition forming a "solder paste"]).

Moreover, claim 7, as amended above, specifically calls for the semiconductor substrate having viscous adhesive material dispensed thereon and "inverting said semiconductor substrate without effecting substantial lateral confinement of said adhesive patch and maintaining said semiconductor substrate in an inverted position at least until said adhesive patch sufficiently stabilizes so as to exhibit a desired stable shape and a lateral boundary defining sizes of said first and second surfaces and wherein at least a substantial portion of said second, smaller surface of said adhesive patch exhibits a generally planar configuration and said size of said second, smaller surface is smaller than said size of said first surface." Thus, claim 7, readily defines over both Aulicino et al. and Schwiebert et al., whether taken separately or combined. This conclusion is reached due to both of these references teaching the formation of spherically-shaped solder balls and do not appear to teach or suggest, inter alia, a semiconductor substrate having at least one adhesive patch exhibiting a first surface adjacent the semiconductor substrate and a second, smaller surface opposite the first surface and wherein the second, smaller surface exhibits a

generally planar portion over a substantial portion of the second, smaller surface of the at least one adhesive patch and the size of the second, smaller surface being smaller than the size of the first surface.

With respect to claim 8, which is dependent upon claim 7, sets forth that "a template, including at least one aperture" is placed on the semiconductor substrate and <u>viscous</u> adhesive material is <u>dispensed</u> into the at least one aperture and that the template is removed "<u>prior to substantially inverting said semiconductor substrate</u>".

Applicants accordingly submit that the combined references being relied upon to support the § 103(a) rejection of claims 7 and 8 fail to teach all the claim limitations of claim 7, and dependent claim 8. For example, and as discussed above, Aulicino et al. teaches that substrate 11, clamped in fixture 15, is inverted as a subassembly (see FIG. 4 and paragraph beginning in column 6, line 50 of Aulicino et al.) to form spherically shaped contacts and Schiebert et al. teaches the formation of a spherically shaped solder bump, which even if used in the flip-chip arrangement of FIG. 3G and 3H as illustrated therein, exhibits a top surface having a final size which appears to be approximately equal to the final size of the bottom surface in contrast with the recitation added toward the end of Applicants' claim 7 as amended above. Therefore, the third element of a *prima facie* case for obviousness has not been met with respect to claim 7 and 8.

Claims 15 and 16 are directed toward flip-chip having at least one conductive bump formed in accordance with respectively set forth process steps. Claim 15, as amended above, now reads:

A flip-chip including at least one conductive bump comprised of a viscous conductive material, the at least one conductive bump exhibiting a height-to-width ratio of at least approximately 3 to 1 and including a first surface adjacent said flip-chip and a second surface opposite said first surface exhibiting a generally planar portion over a substantial portion thereof, said flip chip including said at least one conductive bump formed by:

providing said flip-chip with at least one bond pad;

dispensing a viscous conductive material on said flip-chip defining at least one conductive bump of a selected configuration exhibiting a height-to-width ratio of at least approximately 3 to 1, said at least one conductive bump in

electrical communication with said at least one bond pad of said flip-chip and including a first surface adjacent said flip-chip and a second surface opposite said first surface; and

inverting said flip-chip without effecting substantial lateral confinement of said viscous conductive material and maintaining said flip-chip in an inverted position at least until said conductive bump substantially stabilizes so as to exhibit a desired stable shape and lateral boundary substantially defining final sizes of said first and second surfaces of said at least conductive bump and wherein a substantial portion of said second surface of said conductive bump exhibits a generally planar configuration.

Thus, the present invention as claimed in claim 15, as amended, is further readily distinguishable over the combined teachings of Aulicino et al. and Schwiebert et al. because neither of these references are directed toward providing a conductive bump having a height-to-width ratio of at least approximately 3 to 1 as well as a conductive bump having a generally planar configuration over a substantial portion of a second surface opposite a first surface positioned adjacent the flip-chip.

Claim 16, as amended above, sets forth further limitations to base claim 15 including "placing a template, having at least one aperture, on said flip-chip" and "removing said template prior to substantially inverting said flip-chip". As discussed above, Aulicino et al. and Schwiebert et al., fail to teach or suggest all of the claimed structural limitations now included in Applicants' claim 15 thereby failing to meet the third element of a *prima facie* case for obviousness with respect to claims 15 and 16.

For the reasons stated above, applicants submit that a *prima facie* case for obviousness has not be met with respect to any of claims 7, 8, 15 and 16. Applicants therefore respectfully request that the obviousness rejection of claims 7, 8, 15 and 16 be withdrawn and the claims allowed.

Claim 21 has been amended by Applicant to more precisely and more distinctly claim the adhesive coated lead frame as set forth therein. Applicants again note that the status of claim 21 appears to have been inadvertently omitted from the Office Action mailed October 3, 2000, and respectfully requests the Office to confirm claim 21 is currently pending and that the above amendments made to claim 21 have been entered.

Newly submitted claims 22 - 60:

Newly submitted claims 22 - 42 set forth additional limitations to each of their respective independent base claims and/or respective intervening claims. The subject matter set forth in each of the above identified newly submitted claims 22 - 42, which is consistent with the amendments made to respective base claims, is supported by the specification and drawings of the present application. For example, support for "angles of repose" can be found on pages 13 and 14 of the specification and support for "viscously dispensed materials" can be found on pages 10, 11, 17, and 18 of Applicants' specification.

Newly submitted claims 43 - 60 are generally directed toward articles respectively claimed in claims 7, 8, 13, 14 - 16, and 21 - 42. However such newly claims 43 -60 do not include language directed to processes of rendering such articles. Applicants believe no new matter has been added to the specification by way of the newly submitted claims as support can be found within the specification and drawings of the present application.

CONCLUSION

Claims 7, 8, 13-16, and 21 as well as newly submitted claims 22 - 60 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, the Examiner is respectfully invited to contact Applicants' undersigned attorney.

Respectfully submitted,

Stephen R. Christian Registration No. 32,687

Attorney for Applicants

TRASK BRITT P.O. Box 2550

Salt Lake City, Utah 84110 Telephone: (801) 532-1922

SRC/jml:dlm

Date: January 3, 2001

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